

AD-A092 803

ARIZONA UNIV TUCSON DEPT OF PSYCHOLOGY
TOPICALIZATION EFFECTS IN MEMORY FOR TECHNICAL PROSE.(U)
AUG 80 D E KIERAS

F/G 5/10

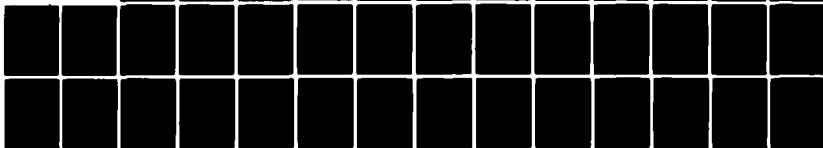
N00014-78-C-0509

UNCLASSIFIED

TR-6

NL

1 of 1
AD
4/28/2013



END
DATE
FILMED
1 81
DTIC

4-
LEVEL II

(12)

Topicalization Effects in Memory for Technical Prose

David E. Kieras
University of Arizona

AD A092803

DTIC
ELECTRIC
S DEC 11 1980
E

Technical Report No. 6 August 30, 1980

This research was supported by the Personnel and Training Research Programs, Office of Naval Research, under Contract Number N00014-78-C-0509, Contract Authority Identification Number NR 157-423. Reproduction in whole or in part is permitted for any purpose of the United States Government.

Approved for Public Release; Distribution Unlimited

DDC FILE COPY

80 12 10 005

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report No. 6	2. GOVT ACCESSION NO. AD-A092 803	3. RECIPIENT'S CATALOG NUMBER 1-17-6
4. TITLE (and Subtitle) Topicalization Effects in Memory for Technical Prose		5. TYPE OF REPORT & PERIOD COVERED Technical Report August 30, 1980
7. AUTHOR(s) David E. Kieras		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Psychology University of Arizona Tucson, AZ 85721		8. CONTRACT OR GRANT NUMBER(s) N00014-78-C-0509
11. CONTROLLING OFFICE NAME AND ADDRESS Personnel and Training Research Programs Office of Naval Research (Code 458) Arlington, VA 22217		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61153N; RR 042-06 RR 042-06-02; NR 157-423
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 167 AL 4-222 167 AL 4-1602		12. REPORT DATE 30 August 1980
		13. NUMBER OF PAGES 40
		15. SECURITY CLASS. (of this report) unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Reading, Comprehension, Abstraction		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The perceived topic of a passage should determine what information is given priority in storage effort for later recall. The topic should also determine how effective a later recall cue should be, in that recall should be best if the cue is the same as the passage topic. These issues were studied by investigating cued recall of passages that contained information about two candidate topics, either of which could be marked as		

DD FORM 1473
1 JAN 73EDITION OF 1 NOV 68 IS OBSOLETE
S/N 0102-014-66011

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

41

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

the passage topic by initial mention or the sentence surface subject position. The recall cue either matched or mismatched the marked candidate topic. If the cue matched the topic, recall about the marked item was greater than recall about the unmarked item. If the cue mismatched the topic, recall about the two items was roughly the same, unaffected by the topic marking. But the matching and mismatching cues produced the same overall level of recall. In contrast to the original hypothesis, the results are interpreted as the topic marking and recall cue acting as instructions for what information the subject should emphasize in recall. It is argued that the two-topic passages used in this work are processed differently than the usual one-topic passages used in prose memory studies.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Topicalization Effects in Memory for Technical Prose

David E. Kieras
University of Arizona

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or special
A	

Technical Report No. 6
August 30, 1980

This research was supported by the Personnel and Training Research Programs, Office of Naval Research, under Contract Number N00014-78-C-0509, Contract Authority Identification Number NR 157-423. Reproduction in whole or in part is permitted for any purpose of the United States Government.

Approved for Public Release; Distribution Unlimited

Abstract

The perceived topic of a passage should determine what information is given priority in storage effort for later recall. The topic should also determine how effective a later recall cue should be, in that recall should be best if the cue is the same as the passage topic. These issues were studied by investigating cued recall of passages that contained information about two candidate topics, either of which could be marked as the passage topic by initial mention or the sentence surface subject position. The recall cue either matched or mismatched the marked candidate topic. If the cue matched the topic, recall about the marked item was greater than recall about the unmarked item. If the cue mismatched the topic, recall about the two items was roughly the same, unaffected by the topic marking. But the matching and mismatching cues produced the same overall level of recall. In contrast to the original hypothesis, the results are interpreted as the topic marking and recall cue acting as instructions for what information the subject should emphasize in recall. It is argued that the two-topic passages used in this work are processed differently than the usual one-topic passages used in prose memory studies.

Acknowledgements

Thanks are due to Gary Foulke, Susan Bovair, Mark Stempski, Jim Lentz, and Kathy Warrick for their assistance in collecting and analyzing the data described in this report.

Topicalization Effects in Memory for Technical Prose

David E. Kieras
University of Arizona

Some of the information in a piece of prose is more important than the rest of the information. If one is asked to study a passage, one should remember the more important information better than the less important information. This fact is well documented under the name of the "levels effect" in which information at a high level of importance in a propositional analysis of a passage is better recalled than information at low levels (see Johnson, 1970; Kintsch & Keenan, 1973; Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975; Kozminsky, 1977; Meyer, 1977). The importance level is defined in terms of the hierarchical semantic structure of the passage information.

The role that importance level plays in current theory of prose memory is best represented by the macrostructure theory of comprehension (Kintsch, 1977; van Dijk, 1977; Kintsch & van Dijk, 1978). According to this theory a reader selects or constructs a set of macrostructure propositions from the microstructure propositions presented by the passage. The macrostructure represents what the reader perceives as being the gist or important content of the passage. It is this information that the reader will attempt to store in memory. The levels effect appears because propositions higher in the passage microstructure will usually be important macropropositions as well, or closely related to the macropropositions, and so are likely to be stored and later recalled by the reader.

Although the semantic content of the microstructure is the main determinant of which propositions are important, the surface structure of the passage should play a role as well. There are many features of textual surface structure that signal what content is important, or thematic (van Dijk, 1979). Hence an effective surface-level signal should influence both readers' judgements of the topic or theme of a passage, and readers' recall of the passage. One such signal is a title for the passage. Kozminsky (1977), using passages with two alternate themes, found that recall was biased in favor of propositions relevant to the theme mentioned in the title. Another important surface-level signal is initial mention; items or ideas appearing first in a passage tend to be viewed as thematically important just by virtue of their position (Kieras, 1980). There is some evidence that natural passages often contain the main content early in the passage (Kieras, Note 1; Meyer 1977; Kintsch et al., 1974). Better recall of this initially-appearing important information has been reported, and

has usually been attributed to the effect of the importance level (e.g., Kintsch, et al., 1974; Meyer, 1977). However, many such studies showing the greater recall of higher importance information usually confounded semantic or structural level of importance with the surface-level signal of initial mention.

Another important surface-level signal to thematic content is the topic-comment assignment of items mentioned in individual sentences (van Dijk, 1979; Perfetti & Goldman, 1974, 1975). The simplest form of this signal is simply which item appears as the surface subject of the passage sentences. Kieras (in press) found that this signal influenced what readers chose as the topical item of a passage; a particular candidate topic was chosen as the passage topic more often if it appeared as the surface subject of the sentences. Clements (1979), using sentence topic-comment assignments, and other aspects of assigning thematic importance, found that material marked as important was recalled better than unmarked material.

Thus, the reader uses not only the semantic content of the passage, but also theme-signaling surface features to construct a macrostructure for the passage, which specifies which propositions are important, and which are not. Priority for encoding effort is given to the propositions at the top level of the macrostructure, while the low level ones get less effort.

The macrostructure theory mainly deals with construction and storage of important passage information. But consider how readers might retrieve information from a previously studied passage when given a cue to the content. A notion advanced here is that the macrostructure of the passage not only determines what is to be stored, but also what the retrieval routes for that information might be. That is, the reader selects the main item, or main referent, of the passage, around which the macrostructure should be organized (see van Dijk, 1979; Kieras, 1980), and uses this perceived topic as a sort of "address" for storage. When given a cue for recall, the reader looks first under the corresponding "address" in memory for the passage information. If the desired information is found, recall proceeds smoothly. If not, the retrieval attempt will be disrupted, and a different retrieval strategy must be used, resulting in poorer recall. Hence the originally perceived topic of a passage will influence the effectiveness of a recall cue; a cue that matches the topic should be superior to one that mismatches. Such an effect would be a prose memory analog to the "encoding specificity" principle studied heavily in verbal learning.

These topic and cue effects in recall would be important in a practical setting in the design of documents such as technical manuals for equipment maintenance. Suppose that a technician discovers that he or she had to make a certain adjustment on a piece of equipment that was described in a piece of prose material read earlier. The name of the adjustment is the retrieval cue; if this item was originally perceived as the topic of the prose material, recall of the adjustment procedure

should be better than if the adjustment had appeared only as a piece of detail on the fringes of the passage macrostructure.

Unfortunately, most recent prose memory studies use either a free recall paradigm, or do not manipulate both the recall cue and the passage topic. The two studies reported here fill this gap concerning the role of topicalization in cued recall, using brief technical passages. The question is whether marking an item as the passage topic affects cued recall for propositions about that item. Initial mention is the topicalization marker employed in Experiment 1, and initial mention and surface subject assignment are used in Experiment 2. An important feature of these experiments is that the topic marking was done independently of the specific passage content. Thus recall of exactly the same material can be compared for when it is marked as a topic and when it is unmarked. This was achieved by using passages chosen from earlier studies (Kieras, Note 1, 1980) that each had two candidate topics, either of which could be marked as the passage topic. Recall was compared for cases in which the different candidate topics were marked as the passage topic, and the different candidate topics served as the recall cue.

EXPERIMENT 1

In this experiment, several two-topic passages were used, with the topic marking produced by which candidate topic was described first in the passage. Kieras (1980) showed that readers tend to view the first-mentioned item in such passages as the topic. An example passage is shown in Table 1, in which the two candidate topic items, labelled A and B, are Biotransformation and The Liver. The passage consists of two sentences about item A, two sentences about item B, and a linking sentence that connects them. The A-first version consists of the two A sentences followed by the linking sentence followed by the two B sentences. In the B-first version, the B sentences appear first, then the linking sentence, and the A sentences come last. The passages were prepared to be reasonably comprehensible in both versions.

Such passages are rather unnatural, but the use of unnatural verbal material is a standard method of gaining experimental control. Furthermore, Kieras (1980) showed that such passages produced well-behaved effects in tasks requiring the subject to pick one of the two candidate topics as the passage topic. Hence use of such materials to study topicalization effects in recall is justified, although there are problems in ensuring that the two candidate topics are of equal salience (see Kieras, Note 1, 1980). But these results show that recall is influenced by which candidate topic was marked by initial mention and also by which was cued.

Table 1

A-First and B-First Versions of an Example Two-Topic Passage

A-First Version

Biotransformation is the chemical transformation that causes the inactivation of drugs, the detoxification of environmental pollutants, and the deactivation of chemicals that can cause cancer. Biotransformation of harmful agents involves an oxidation reaction which is mediated by complex enzymes, and if this process does not take place, a drug entering the body may act indefinitely. Biotransformation defends the body against the effects of toxins and is carried out in the liver. The liver, weighing three pounds in the human adult, is the largest organ in the body and performs diverse functions. Through the large portal vein of the liver passes all the blood that has absorbed digested food and other substances from the intestines.

B-First Version

The liver, weighing three pounds in the human adult, is the largest organ in the body and performs diverse functions. Through the large portal vein of the liver passes all the blood that has absorbed digested food and other substances from the intestines. Biotransformation defends the body against the effects of toxins and is carried out in the liver. Biotransformation is the chemical transformation that causes the inactivation of drugs, the detoxification of environmental pollutants, and the deactivation of chemicals that can cause cancer. Biotransformation of harmful agents involves an oxidation reaction which is mediated by complex enzymes, and if this process does not take place, a drug entering the body may act indefinitely.

Method

Materials. Eight passages were selected from those reported in Kieras (Note 1, Experiment 4) that showed good effects of the initial mention variable. These passages would thus be expected to produce different apparent topics when presented in the two orders. A propositional analysis was performed on the passages, based on Kintsch (1974) and Turner and Greene (Note 2). For each passage, two cues, one or two words long, were devised that named each candidate topic of the passages. The passages were prepared as small booklets, one for each subject, one passage per page.

Design. The experiment was within-subjects, with four conditions, corresponding to the two passage versions, A-first or B-first, combined with the two possible cues, the A cue or the B cue. A series of 8 by 8 random latin squares was used to determine the assignment of passages to version and cue conditions for each subject, ensuring that for multiples of eight subjects, each passage would appear twice in each condition, and each subject saw each condition twice and each passage once. Another series of latin squares was used to balance the order of appearance in the booklets.

Subjects. Forty-eight subjects of both sexes participated for extra credit in an introductory psychology course. The session required about one hour.

Procedure. The subjects were run in groups of up to twenty in size. The subjects studied each passage in their booklets, being paced by the experimenter at one minute per passage. After reading all eight passages, subjects immediately began working on a distractor task consisting of a large sheet of arithmetic problems. After eight minutes had elapsed, subjects were instructed on the recall procedure. Each subject was given a booklet consisting of eight pages, with a cue word for one of the passages at the top of each page. The recall cues were arranged in the same order as the passages for each subject. The subjects were instructed to write as much as they could remember, in their own words, of the passage corresponding to the cue word. They were paced at three minutes for each passage recall attempt.

Results

The recall protocols were scored blind, without knowledge of the original passage version condition, for reproductions of the passage propositions. The scoring criterion was fairly strict; only exact reproductions of propositions, with synonyms allowed, were counted as recalled. This, together with the delayed-recall procedure, produced a fairly low level of recall, around 11% on the average. Two independent blind scorings were performed on the recall protocols, and then the scorer was included as a factor in the analysis. Recalled propositions about each candidate topic item were tabulated, but the propositions from the linking sentence were not included. Hence

the analyses were done only on the recall of propositions from the two sentences about each item. The amount of recall was converted to proportions to eliminate the slight differences in the number of propositions contained in the sentences and subjected to an ANOVA. The factors in the analysis were the scoring rater, the item of recall, whether the cue matched or mismatched the first-presented item, and the passage version. In these experiments, the materials were not randomly sampled, but carefully constructed and selected to produce the intended topic manipulation. Hence passages were not treated as a random factor (see Wike & Church, 1976; Clark, Cohen, Smith, & Keppel, 1976).

The second rater produced scores that were very slightly higher than the first rater (10.6% versus 11.3%) which although marginally significant ($F(1,47)=3.25$, $p<.1$) shows very good uniformity in the scoring. The only other rater effect to appear was in the highest order interaction, which will be discussed below.

The mean proportions of recall of each candidate topic item in each condition are shown in Table 2. The main results appeared in two interactions. The item by version interaction was significant ($F(1,47)=14.82$, $p<.01$). This effect was that recall of a item was best when that item was presented first. But the key result is shown in Table 2. This interaction of item with cue and version was strongly significant ($F(1,47)=34.49$, $p<.01$). As shown in the table, when the cue matches the first-presented item, recall of this item is higher than for the other item. However, if the cue mismatches the first-presented item, the passage version has no effect on recall. Note that recall of propositions about the B items was greater than about the A items, being 13.3% versus 8.8% ($F(1,47)=30.28$, $p<.01$).

The interaction of the three-way interaction with rater, alluded to above, was significant ($F(1,47)=8.75$, $p<.01$), but presents no problem in interpretation because the ordering of the cell means for each rater show exactly the same pattern. The four-way interaction means only that the first rater's scores show the Table 2 interaction slightly more strongly than the second rater's scores. No other effects approached significance.

DISCUSSION

The result that information about an item presented first in a passage is recalled better than for an item presented later duplicates that reported by Meyer (1977) and others that recall is better for the first mentioned material. However, this result is stronger in this study since order of appearance in the passage was manipulated separately from the semantic content associated with the item. Thus even though the most important content normally appears first in a passage, initial mention influences recall because it has topic-signalling value in itself.

Table 2

Mean Proportion of Recall About Each Item

		Item of Recall	
		A	B
Matching	A	.14	.07
	B	.07	.18
MisMatching	A	.07	.15
	B	.07	.13

Note. The standard error of these means is about .01.

The results in Table 2 however, contain a more theoretically interesting result, that recall about an item is specific to the relation of the recall cue to the originally perceived passage topic. That is, if the cue matches the perceived topic, recall favors the cued item, but if the cue mismatches, the originally perceived topic is irrelevant to the amount of recall. The topic apparently does not govern what the reader stores, since in the mismatching cue case there is no effect of the passage version. Rather, the originally perceived topic seems to determine how useful a later recall cue will be.

There are two problems with these results. The first problem is that the item B propositions are better recalled overall than item A propositions, which confuses the results. In contrast, as presented in more detail in Kieras (Note 1, 1980), in these passages the A items are generally preferred to the B items as passage topics. A possible explanation for the difference between the items is that the B items showed a tendency to be more specific than the A items, and the facts stated about the B items tended to be more specific and concrete. Although the A-B label is clearly arbitrary, in practice the passages were composed by starting with an A item and trying to devise a suitable B item; this process apparently resulted in differences in item salience. For example, the passage shown in Table 1 had Biotransformation, a general type of metabolic process, as item A and The liver as item B. Fairly general statements were made about biotransformation, while rather specific facts were stated about the liver. It could be that the more general candidate topic makes the best choice for the passage topic, since it logically subsumes the other possible passage topic, but highly specific facts about a specific item are easier to recall in this type of memory experiment. This problem was explored in the second experiment by using passages for which normative topic choice data was available, and comparing passages that showed either a strong bias in favor of one item being the topic, or essentially no such bias.

The second problem is that since the topic marking manipulation involved a serial position manipulation, the observed effects may be due to simple serial position effects rather than to topic marking. Thus the results could be explained as follows: In the matching cue condition, subjects are able to start their recall with the cued item and then recall the passage sentences in the same order as originally presented. The unmarked item information is recalled poorly because it is recalled last, and so suffers from output interference. Hence a result like Deese and Kaufman's (1957) primacy-only serial position curve appears. In the mismatching cue condition, the cue encourages the subject to start in the middle of the passage, thus disrupting the normal serial order of recall, leading to poorer performance, and making the original version of the passage irrelevant.

The attack on this problem used in Experiment 2 was to include a different passage topic marker, sentence surface subject assignment. This marker would allow different candidate

topic items to be marked as topical by changes in the sentences, without changing the order of the sentences in the passage. Also, detailed data was collected on the order of sentences in the recall protocols, which would allow serial position effects in recall to be directly examined.

EXPERIMENT 2

In this experiment, passages of three types were used: balanced, biased, and surface subject. The balanced and biased passages appeared in either the A-first or the B-first order. The balanced passages were selected to show little or no bias in item choice, and the biased were chosen to show a strong bias. The surface subject passages appeared in either of two versions, which differed only in which candidate topic appeared as the surface subject of all of the passage sentences. As in Experiment 1, recall was cued with either of the two candidate topics.

Method

Materials. Using the materials and results from Kieras (1980, in press), six passages were selected, two of each of the three types balanced, biased, and surface subject. The candidate topic items of the passages used, together with the proportions of choices of each item and the sample size for these proportions, are shown in Table 3. The balanced and biased passages were chosen from those used in Kieras (1980), in which subjects chose one of the two candidate topics in a forced-choice procedure. The surface subject passages were chosen from those used in Kieras (in press), in which subjects generated noun phrase statements of the passage topics; these were scored for which one of the candidate topics they referred to. Since the statements may have referred to something else, these choices are not exhaustive. For ease in reference here, the label of item A was assigned to the candidate topic that was preferred, even slightly, in each passage.

The balanced passages were chosen to show a symmetrical effect of initial mention on topic choice with very little bias in favor of one of the items. As can be seen in Table 3, for both balanced passages, there is a strong initial mention effect, and the choices of the two items overall are almost of equal frequency. The biased passages were chosen to show a strong topic bias. The Table 1 example is a biased passage used in this experiment. As shown in the table, there is a strong bias in favor of item A, which in both passages is a very general abstract concept, while item B is a very specific and concrete item. The effect of topicalizing B by initial mention is only to weaken the preference for item A. Finally, the surface subject passages were chosen to show a substantial effect of which candidate topic was marked by appearing as the surface subject of the passage sentences. Table 4 shows one these passages; item A is vaccines, and item B is virus. Due to the difficulty of composing such passages, equating the items

Kieras

Table 3
Proportion of Choices of Item A and Item B
for Each Passage Type.

		Topicalization					
		Version					

		A		B		Overall	
		-----		-----		-----	
Passage Items (A/B)	Choice:	A	B	A	B	A	B

<u>Balanced (N=24)</u>							
Corona/Solar Wind		.83	.17	.29	.71	.56	.44
Isomers/Retinene		.79	.21	.25	.75	.52	.48
<u>Biased (N=48)</u>							
Bioluminescent light/flashlight fish		.83	.17	.65	.35	.74	.26
Biotransformation/liver		.94	.06	.60	.40	.77	.23
<u>Surface Subject (N=11)</u>							
Vaccine/virus		.91	.00	.36	.27	.64	.14
radio galaxies/Radio waves		1.0	.00	.45	.55	.72	.27

Table 4

The A-Topicalized and B-Topicalized Versions
of an Example Surface Subject Passage

A-Topicalized Version

A vaccine is prepared by somehow weakening a virus, often by inactivating the DNA and using the protein coat which can be injected to stimulate the immune system of the body. Vaccines require for their preparation the keeping of a large supply of virus that is usually grown in systems such as egg or cell cultures. A vaccine is now under test that may soon control the virus, Hepatitis B, that produces a serious and very debilitating disease. Vaccines have become available against many viruses that once caused diseases which were common and often incurable although some diseases still cannot be controlled this way. Vaccines were originally discovered and developed by men like Jenner who showed that the virus that causes cowpox, a very mild disease, could prevent infection by the dreaded smallpox.

B-Topicalized Version

Viruses that have somehow been weakened, often by inactivating the DNA and using the protein coat, are used to prepare vaccines which can be injected to stimulate the immune system of the body. Viruses must be kept in large supply in order to prepare vaccines and are usually grown in systems such as egg or cell cultures. The virus, Hepatitis B, that produces a serious and very debilitating disease may soon be controlled by a vaccine now under test. Viruses once caused many common and often incurable diseases until vaccines against them became available, although some diseases still cannot be controlled this way. The virus that causes cowpox, a very mild disease, was shown by Jenner, one of the original discoverers and developers of vaccines, to prevent infection by the dreaded smallpox.

on salience was not attempted for the work in Kieras (in press); the item choices are thus biased. But notice that there is not an obvious difference in the generality or concreteness of the two items, as is the case in the biased passages. Thus, in the A-topicalized versions of the passages, A was quite the dominant choice for the topic, but in the B-topicalized versions, A and B were chosen roughly equally often. Thus overall, there is a bias in favor of A.

As in Experiment 1, for the balanced and biased passages, the B-topicalized version consisted simply of the same sentences as the A-topicalized version in a different order. The surface subject passages, however, contained different sentences in the two versions, which conveyed the same propositional content, but differed in which candidate topic appears in the subject and which in the predicate. All of the passages were five sentences long, and were computer justified and printed to occupy about 14 lines. Each passage was printed on a separate page, and the pages assembled into booklets for each subject. Each subject's booklet contained first a page of instructions, followed by six passage pages, followed by a page of arithmetic problems for a distractor task, followed by a page of recall instructions and six recall pages, each containing a cue word that was one of the two candidate topics for one of the passages. The cue words appeared in the same order as the corresponding passages. The order of appearance of the passages in the booklets was separately randomized for each subject's booklet.

Design. The design was between-subject; there were four groups, each of 15 subjects, one for each combination of passage version (A topicalized or B topicalized) and recall cue (A or B). Each subject studied the appropriate version of each of the six passages. The design ensured that if a multiple of four subjects were run, each passage appeared equally often in each version-cue combination.

Subjects were assigned to one of the four version-cue combinations in the order that they appeared for the experiment, with each combination used once in each consecutive group of four subjects.

Subjects. Subjects were 60 University of Arizona undergraduates, recruited through campus advertisements, who were paid \$2 for participating in the one-hour experiment.

Procedure. Subjects were run in groups of one to several people. After reading the instructions on the first page of the booklet, the subjects read each passage in their booklets one at a time, being paced at 2 minutes per passage. The instructions asked the subjects to try to remember the facts and ideas in each passage and not to attempt to memorize the exact wording. After completing study of the last passage, the subjects worked the page of arithmetic problems for eight minutes. Then the subjects read the recall instructions, and then began to work on the recall pages in the booklet which were blank except for a cue word at the top of each page. They were instructed to recall in their own words as much as they could remember about

the passage corresponding to the cue word, writing in the space provided on the page. They were paced at three minutes per recall page, and were not allowed to go back.

Results

Recall. The passages were propositionalized as in Experiment 1, and the recall protocols were scored for reproduction of each passage proposition. The scoring was done blind with regard to the presented version for the balanced and biased passages, and blind with regard to the recall cue for the surface-subject passages. Scoring was done independently by two judges, and then a third judge reconciled the two sets of scorings to yield a final single scoring.

Two scoring criteria were used, one a strict scoring in which only exact reproductions of propositions, with synonyms permitted, were counted. A liberal scoring was also done, in which all propositions were counted as recalled that the subject must have known in order to produce his or her recall protocol. In the major analyses, this highly subjective scoring yielded results comparable with the strict scoring, but produced weak and ambiguous effects in the secondary analyses of each passage type. Hence the strict scoring only will be reported.

The passage propositions were labelled according to whether they were about item A, item B, or something else. A proposition was designated as being about an item if it either contained the item as an argument, or it embedded or was embedded by a proposition that did.

The data were then expressed as proportions of presented propositions that were recalled for each subject for each candidate topic item in each passage, and subjected to ANOVA. The within-subject factors were passage type (balanced, biased, and surface subject), passages within types, and item of recall (A or B). The between-subject factors were passage version (A topicalized or B topicalized) and cue type (matching the topicalized item, or mismatching the topicalized item). Table 5 presents the mean proportions of recall for the strict scoring, for each combination of passage type, item of recall, passage version, and matching or mismatching cue.

Overall the liberal scores were considerably higher, with a mean of about .36 compared to the strict score mean of .16. Since the key effects in the strict scores are replicated in the liberal scores, the effects can not be attributed to floor artifacts, despite the low level.

In the strict score ANOVA, there was a main effect of item of recall, in which topic B was recalled more, at .18, than A, at .14 ($F(1,56)=13.61$, $p<.01$). This result is similar to that in Experiment 1, in which A, the predominant topic, was recalled less than B. There was no main effect of passage version ($F<1$). Note especially that there was no main effect of cue type ($F<1$). There was a main effect of passage type: Balanced were recalled

Table 5
 Mean Proportion of Recall about Each Item
 for Each Passage Type

		Passage Type							
		Balanced		Biased		Surface Subject		Mean	
Item of Recall:	Version	A	B	A	B	A	B	A	B
Matched	A	.20	.11	.20	.26	.17	.13	.19	.17
	B	.13	.18	.05	.25	.11	.16	.10	.20
Mismatched	A	.11	.12	.12	.30	.12	.10	.12	.17
	B	.17	.19	.18	.23	.16	.12	.17	.18

Note. The standard error of these means is about .05 for between-subject comparisons and about .04 for within-subject comparisons.

at .15, biased at .20, and surface subject at .13 ($F(2,112)=8.94$, $p<.01$). There was also a main effect of passages within types ($F(3,168)=13.58$, $p<.01$), and an interaction of item of recall with passages ($F(3,168)=13.82$, $p<.01$). The effect of item of recall differed for passage types ($F(2,112)=15.34$, $p<.01$), as can be seen in the means in Table 5. This interaction is that both items were recalled equally well overall for the balanced and surface subject passages, but for the biased passages, item A was recalled at the same mean level as in the other types, but item B propositions are recalled about twice as often.

The key result is the interaction between item of recall, passage version, and cue type ($F(1,56)=19.88$, $p<.01$), shown in the last columns of Table 5. The effect is that for matching cues, there is the same topic effect seen in Experiment 1, in which recall of a item is superior if it was originally topicalized. For the mismatching cue, the recall does not follow this pattern, but shows the overall recall superiority of item B. Inspection of the table shows that this pattern differs over the passage types, but the four-way interaction including passage type was not significant ($F(2,112)=1.35$, $p>.1$). However, this could be due to low power, since the analyses below show clear differences between the passage types.

Recall in Each Passage Type. Three separate ANOVAs were done on the strict scores, one for each passage type, including all of the previous factors except passage type. These show how the overall results appear in each passage type.

The balanced passages showed a main effect of passage ($F(1,56)=23.41$, $p<.01$) but no interaction of passage with other factors. Item of recall and version interacted ($F(1,56)=4.42$, $p<.05$), such that recall of B was higher for version B, but lower for version A, whereas recall of A was unaffected by version. The main result appeared as the interaction between recall item, version, and cue type, which just missed significance at .05 ($F(1,56)=3.81$, $p<.1$). As shown in Table 5, there was a strong topic effect for matching cues, but for the mismatching cues, there was only an effect in which the B version was better for both items of recall.

The surface subject passages were similar to the balanced passages. Again there was a main effect of passages ($F(1,56)=20.52$, $p<.01$), but there was an interaction of passage with recall item and version ($F(1,56)=5.20$, $p<.05$). However the main result again appeared in an interaction between recall item, version, and cue type (see Table 5) that resembled the balanced passages ($F(1,56)=5.20$, $p<.05$). Again there is a topic effect for the matching cue.

The biased passages, however, were rather different from the other two types. There was, as it happened, no main effect of passage, but there was an interaction between item of recall and passages ($F(1,56)=33.10$, $p<.01$) in which one of the passages produced equal recall of A and B, whereas the other, the biotransformation/liver passage, produced a large amount of

recall about B. Correspondingly, there was a strong main effect of item of recall ($F(1,56)=25.27$, $p<.01$). The three-way interaction between item of recall, version, and cue type was again significant ($F(1,56)=8.15$, $p<.01$), but as shown in Table 4, followed a different pattern than in the other types. Recall of B was superior overall compared to A; if the cue matched the version topic, recall of B was unaffected, but A recall was better in the A-topicalized version than in the B-topicalized version. If the cue mismatched, recall of a item appears to be better when the cue corresponds to the item of recall (that is, the mismatched cue for the A version is B, and for the B version is A), meaning that the passage version is relatively unimportant. The two individual biased passages, despite the differences in amount of recall of the items, both follow this pattern.

Summary of Recall Results. For all passage types, there is no effect of cue type; mismatching cues produced the same overall level of recall as matching cues. For matching cues, the balanced and surface subject passages show better recall of the item marked as topical by the passage version than for the unmarked item. In the biased passages with matching cues, recall of the preferred topic, the abstract general item A, is better if it is marked by initial mention, but recall of the specific, concrete item B is unaffected, and is higher than item A recall.

For mismatching cues, the results are less neat: The balanced passages show better recall of both items in the B-topicalized version than in the A-topicalized, and the surface subject passages show no differences except for better recall of A compared to other conditions when it is cued with the mismatching A cue in the B-topicalized version. Finally, for the biased passages, the recall of an item seems to be best under the corresponding cue, even though the cue mismatched the passage topicalization. The simplest summary of the mismatching cue results is that each item of recall was either marked as the passage topic, or appeared as the recall cue. Apparently, in either case, recall of the corresponding item benefitted, but the relative strength of these two benefits was not clear-cut, producing no clear pattern in the mismatching cue condition.

Order of Recall. The order of recall of passage information was analyzed as follows: In scoring the recall protocols, for each proposition scored as recalled, the serial number of the subject's sentence containing that proposition was noted. Hence if a subject recalled a certain proposition in his or her third sentence in the recall protocol, that proposition was assigned a recall sentence number of 3. Protocols containing either no recall or only one sentence of recall for a passage were not included. The average sentence of recall for propositions expressed in each of the original passage sentences is shown in Table 6. Note that for balanced and biased passages, sentences 1 and 2 contain the propositions about the first-mentioned item, and sentences 4 and 5 those about the second-mentioned item. For surface subject passages, each sentence contained both items. Overall, the recall sentence

Kieras

Table 6
Mean Number of Sentence of Recall for
Propositions in each Original Passage Sentence

			Passage Sentence				
Passage Type	Cue Type	Version	1	2	3	4	5
Balanced							
	Matched	A	1.21	2.16	2.88	2.81	3.69
		B	1.36	2.22	2.86	3.63	4.45
	MisMatched	A	2.16	2.07	2.03	1.79	2.51
		B	1.54	2.45	2.27	2.76	2.92
Biased							
	Matched	A	1.11	2.14	2.52	3.17	3.39
		B	1.39	2.25	3.00	2.64	3.92
	MisMatched	A	1.71	2.07	2.69	2.08	3.45
		B	1.62	1.95	2.08	2.77	3.69
Surface Subject							
	Matched	A	1.51	2.45	2.93	3.46	3.50
		B	1.38	2.94	2.86	2.71	3.14
	MisMatched	A	1.71	2.29	2.82	3.50	3.47
		B	1.51	2.09	2.62	2.98	4.16

numbers increase smoothly with the original passage sentence numbers, meaning that the recall was generally written in the same order as the original passage information appeared in. Two conditions stand out as violating this relationship: In the balanced passages, the A Version Mismatching Cue condition has B recall coming both first and last on the average, with A recall in the middle. In the surface subject passages, the B Version Matching Cue condition shows a reversed order of the middle sentences. With these two exceptions, the correspondence to input order is very good.

A simple correlational analysis was done to assess the relative importance of version and cue on recall sentence order. The recall sentence numbers were converted to a proportionate measure by dividing them by the number of sentences in the recall protocol. Point-biserial correlation coefficients were then computed separately for propositions about item A and item B, with the mean sentence number of recall being the continuous variable, and either version or cue being the dichotomous variable. Each individual recall protocol for a passage contributed one data point. These correlations, along with their t values and significance, are shown in Table 7.

Notice first of all that the correlations are essentially zero for the surface subject passages; since each sentence mentioned both items, this is to be expected. But note that from Table 6, recall order was still substantially the same as input order for these passages. Hence, neither version nor cue influenced order of recall for the surface subject passages.

Next consider the correlations for the biased passages. The correlation of version with recall order is much stronger than the correlation of cue with recall order. Finally, for the balanced passages, the correlations of cue with recall average about .27, but the correlation of version with recall averages higher, at about .36. The version correlation for A recall is depressed due to the one bad condition for recall order noted above.

Hence the order of recall generally seems to be closely related to the original version of the passage, with relatively little relation to the recall cue. This suggests that when given a recall cue, subjects generally recall the passage in roughly the same order as the original, regardless of the cue.

DISCUSSION

Simple Serial Order Hypothesis. The hypothesis was presented above that the topicalization and cue effects from Experiment 1 can be explained in terms of output interference resulting from either facilitation or disruption of the subject's strategy of recalling the passage information in the same order as originally read. This hypothesis can be criticized as follows: First of all, it predicts only that the last-recalled information will suffer; it does not naturally explain how or why the recall cue would influence recall.

Table 7
 Mean Proportionate Sentence of Recall
 and Point-Biserial Correlations between
 Sentence of Recall and Passage Version and
 Sentence of Recall and Cue
 for Propositions about each Item of Recall

Passage Type	Item	Version	Mean	<u>rpb</u>	Cue	Mean	<u>rpb</u>
<hr/>							
Balanced	A	A	.68	-.277**	A	.68	-.266*
		B	.81		B	.81	
	B	A	.78	.443**	A	.74	.288**
		B	.57		B	.61	
Biased	A	A	.55	-.565**	A	.61	-.274**
		B	.79		B	.73	
	B	A	.80	.593**	A	.70	.200*
		B	.50		B	.60	
Surface Subject	A	A	.63	-.053	A	.64	.039
		B	.64		B	.63	
	B	A	.72	.016	A	.72	.011
		B	.72		B	.72	

* Value of rpb significant at .05; ** at .01.

Secondly, under this hypothesis, one would expect that the overall level of recall would be worse under the mismatching cue condition than the matching condition, since the mismatching cue would always produce disruption of recall, while the matching one would not. However, the average level of recall did not differ between cuing conditions. Third, the same class of effects was observed for the surface subject passages, in which information about the two items was distributed almost uniformly throughout the passage. Serial order of recall within sentences for the surface subject passages could not be invoked, because the data on surface subject of recall sentences strongly suggests that this information was not retained that well. Finally, the order of recall data gives little support to the disruption hypothesis: Subjects made little effort to recall the cued item information first, but rather generally tried to recall in the same order as the original passage. Hence the hypothetical disruption of recall order has no clear manifestations.

Thus, the observed effects should be attributed to alterations in the perceived topic of the passages, not to disturbances in the order of recall.

Reproduction of Input Order. Apparently subjects can retain certain features of the surface form of a passage, as shown by the similarity between input and output order seen in these results, and observed before by Deese and Kaufman (1957). However, it is not the case that this is simply verbatim memory for the passage content. For one thing, a strict propositional scoring is very sensitive to near-verbatim recall; if the recall had much verbatim content, the scored level of recall would be considerably higher. Thus the low level observed means that there is little verbatim or near-verbatim content in the recall protocols. Another argument that the recall has little verbatim content is based on which item appeared as the surface subject of sentences in the recall protocols for the surface subject passages, in which one item was the subject of all of the sentences. Only 37% of the recall sentences had the same referent for the surface subject as the original passage sentences; 21% had the other candidate topic as the surface subject, and 44% had some other surface subject. Thus even this simple and distinctive feature of sentence surface structure is not very well retained.

How is the similarity between input and output order explained if there is little verbatim-level retention of the passage? What readers could actually be remembering is the order of information in the passage macrostructure. That is, the technical passages used in these experiments could have some schema-like properties in which information is presented in some normative order (see Kieras, Note 3, for further discussion). For example, the first sentence about a topic item was usually a fairly general statement, and was followed by more detailed information. If the passage macrostructure had a tree-like form that was recalled starting with the more important information at the top of the tree and proceeding to the detail information near the bottom of the tree, then the order of output of the

propositions would resemble the order of the propositions in the original passage, even without retention of the actual verbatim surface form.

Distinction between topicality and memorability. The results for the biased passages make the interesting point that topicality and memorability of a passage item are distinct characteristics. The abstract general terms were heavily favored as passage topics, but the specific concrete items subsumed under these topics were much better recalled. This argues that standing in the passage macrostructure is not the only determinant of recall of a passage proposition.

Topics and Cues as Recall Instructions. Both intuition and the memory-location model for topic and cue effects presented above would predict that recall would be best overall for matching cues, and worst overall for mismatching cues. However, the actual results contradict this model. The overall recall does not differ with cue type. Hence, what is being affected is not how much subjects recall from the passage, but rather what subjects recall. This pattern is clearest in the balanced and surface subject passages. When the recall cue corresponded to the original passage topic, the subject favored this topic in his or her recall, but there was some recall about the other, non-marked, item in the matching cue condition. This argues that the subject has memory access to the item although it was neither marked as the passage topic nor cued. In the mismatched condition, the two candidate topics seem to be roughly equally well recalled in these passages. Since one item was marked in the passage, and the other was cued, perhaps subjects were able to give them similar success in recall, again implying that information about the two items is equally available.

Hence the effect of topicalization in these passages does not seem to be that of altering how much information was stored about each item. Rather what could be going on is that the topic marking is an aspect of the passage that the subject stores, more or less independently of the propositions retained. Suppose then, that the reader is asked to recall the passage about a certain item, and also remembers that this item was marked as the topic of the passage. Then he or she interprets this situation as a task demand that this topical item is more important to recall than the unmarked item, and so favors it in the recall effort. If the cued item is not the passage topic, the reader feels little need to favor one of the items over the other, and so recall of the two items is roughly equal. Thus the passage topic and recall cue act like instructions to the subject about what portions of the passage he or she should attempt to recall.

This explanation is in conflict with the macrostructure theory presented above, in which topicalization would govern storage priorities. This theory has been supported by many experiments in which information higher in the passage macrostructure is recalled better than information lower in the macrostructure. It seems reasonable to think that a manipulation that alters the topic of the passage would alter

its macrostructure, and so should change which information would be remembered better. The Kozminsky (1977) study and the Britton, Meyer, Simpson, Holdrege, and Curry (1979) study show just such effects. But there are several differences between the present experiments and those supporting the macrostructure theory. First of all, the usual prose memory experiment is done with a free recall paradigm, or with a cue corresponding to the single, unambiguous passage topic. The passages usually used probably have a "tighter" macrostructure than the two-topic passages used here, in that the structure would be organized around one main item, and would have a relatively neat tree-like structure. But the two-topic passages could be viewed by subjects as having two distinct, but interconnected, structures, one organized around each candidate topic, and one of these marked by the textual surface structure as being more thematically important than the other.

In processing an ordinary passage, the reader could select for storage the most important propositions about the single topic. In processing one of the two-topic passages, the reader could select for storage the most important propositions about each of the two candidate topics, and also remember which was supposed to be more important. When asked to recall, the reader of an ordinary passage has no problem; any cue to the topic corresponds to the top level of the passage information in memory. But the two-topic passage reader must make a choice which of the two structures to emphasize in recall. The relation of the original topic to the recall cue would be used to make the choice.

If this characterization of the present results is accepted, there are two consequences: One is that the macrostructure theory needs to be modified or expanded to take into account what the reader will do with complex technical passages that do not have a obvious structure organized closely around a single topic. Clearly some further experiments should be done on the problem. The second consequence is that certain seemingly simple questions about prose memory may not be easily answered. The original question addressed by these studies was simply whether the topic of a passage governs later recall, content differences being controlled. The two-topic passages seemed a good choice as a method to allow altering which item was topical without making serious changes in the passage content. But if readers process such passages completely differently from single-topic passages, the role of the perceived passage topic in the storage and retrieval of prose information can not be so easily isolated.

Reference Notes

1. Kieras, D. E. Initial mention as a cue to the main idea and main item of a technical passage. Technical Report, University of Arizona, July, 1979.
2. Turner, A., & Greene, E. The construction and use of a propositional text base. Institute for the Study of Intellectual Behavior, Technical Report No. 63. University of Colorado, April, 1977.
3. Kieras, D. E. Abstracting main ideas from technical prose: A preliminary study of six passages. Technical Report, University of Arizona, August, 1980.

References

- Britton, B. K., Meyer, B. J. F., Simpson, R., Holdredge, T. S., & Curry, C. Effects of the organization of text on memory: Tests of two implications of a selective attention hypothesis. Journal of Experimental Psychology: Human Learning & Memory, 1979, 5, 496-506.
- Clark, H. H., Cohen, J., Smith, J. E. K., & Keppel, G. Discussion of Wike and Church's comments. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 257-265.
- Clements, P. The effects of staging on recall from prose. In R. O. Freedle (Ed.), New directions in discourse processing. Norwood, New Jersey: Ablex Publishing Corporation, 1979.
- Deese, J., & Kaufman, R. A. Serial effects in recall of unorganized and sequentially organized verbal material. Journal of Experimental Psychology, 1957, 54, 180-187.
- Johnson, R. E. Recall of prose as a function of the structural importance of the linguistic units. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 12-20.
- Kieras, D. E. Initial mention as a signal to thematic content in technical passages. Memory & Cognition, 1980, 8, 345-353.
- Kieras, D. E. The role of major referents and sentence topics in the construction of passage macrostructure. Discourse Processes, in press.
- Kintsch, W. The representation of meaning in memory. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1974.
- Kintsch, W. On recalling stories. In M. Just & P. Carpenter (Eds.), Cognitive processes in comprehension. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.
- Kintsch, W., & Keenan, J. Reading rate and retention as a function of the number of propositions in the base structure of sentences. Cognitive Psychology, 1973, 5, 257-274.
- Kintsch, W., Kozminsky, E., Streby, W. J., McKoon, G., & Keenan, J. M. Comprehension and recall of text as a function of a content variable. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 196-214.
- Kintsch, W., & van Dijk, T. A. Toward a model of discourse comprehension and production. Psychological Review, 1978, 85, 363-394.

- Kozminsky, E. Altering comprehension: The effect of biasing titles on text comprehension. Memory & Cognition, 1977, 5, 482-490.
- Meyer, B. J. F. What is remembered from prose: A function of passage structure. In R. O. Freedle (Ed.), Discourse production and comprehension: Advances in research and theory, Vol. 1. Norwood, N. J.: Ablex Publishing Corporation, 1977.
- Perfetti, C. A., & Goldman, S. R. Thematization and sentence retrieval. Journal of Verbal Learning and Verbal Behavior, 1974, 13, 70-79.
- Perfetti, C. A., & Goldman, S. R. Discourse functions of thematization and topicalization. Journal of Psycholinguistic Research, 1975, 4, 257-271.
- van Dijk, T. A. Semantic macro-structures and knowledge frames in discourse comprehension. In M. Just & P. Carpenter (Eds), Cognitive processes in comprehension. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.
- van Dijk, T. A. Relevance assignment in discourse comprehension. Discourse Processes, 1979, 2, 113-126.
- Wike, E. L., & Church, J. D. Comments on Clark's "The language-as-fixed-effects-fallacy." Journal of Verbal Learning and Verbal Behavior, 1976, 15, 249-256.

Navy

- 1 Dr. Ed Aiken
Navy Personnel R&D Center
San Diego, CA 92152
- 1 Meryl S. Baker
NPRDC
Code P309
San Diego, CA 92152
- 1 Dr. Robert Breaux
Code N-711
MAVTRAEQUIPCEN
Orlando, FL 32813
- 1 Chief of Naval Education and Training
Liason Office
Air Force Human Resource Laboratory
Flying Training Division
WILLIAMS AFB, AZ 85224
- 1 Dr. Richard Elster
Department of Administrative Sciences
Naval Postgraduate School
Monterey, CA 93940
- 1 DR. PAT FEDERICO
NAVY PERSONNEL R&D CENTER
SAN DIEGO, CA 92152
- 1 Dr. John Ford
Navy Personnel R&D Center
San Diego, CA 92152
- 1 Dr. Henry M. Halff
Department of Psychology, C-009
University of California at San Diego
La Jolla, CA 92093
- 1 LT Steven D. Harris, MSC, USN
Code 6021
Naval Air Development Center
Warminster, Pennsylvania 18974
- 1 Dr. Patrick R. Harrison
Psychology Course Director
LEADERSHIP & LAW DEPT. (7b)
DIV. OF PROFESSIONAL DEVELOPMENT
U.S. NAVAL ACADEMY
ANNAPOLIS, MD 21402

Navy

- 1 CDR Robert S. Kennedy
Head, Human Performance Sciences
Naval Aerospace Medical Research Lab
Box 29407
New Orleans, LA 70189
- 1 Dr. Norman J. Kerr
Chief of Naval Technical Training
Naval Air Station Memphis (75)
Millington, TN 38054
- 1 Dr. William L. Maloy
Principal Civilian Advisor for
Education and Training
Naval Training Command, Code 00A
Pensacola, FL 32508
- 1 Dr. Kneale Marshall
Scientific Advisor to DCNO(MPT)
OPOIT
Washington DC 20370
- 1 CAPT Richard L. Martin, USN
Prospective Commanding Officer
USS Carl Vinson (CVN-70)
Newport News Shipbuilding and Drydock Co
Newport News, VA 23607
- 1 Dr William Montague
Navy Personnel R&D Center
San Diego, CA 92152
- 1 Naval Medical R&D Command
Code 44
National Naval Medical Center
Bethesda, MD 20014
- 1 Mr. William Nordbrock
Instructional Program Development
Bldg. 90
NET-PDCD
Great Lakes Naval Training Center,
IL 60088
- 1 Ted M. I. Yellen
Technical Information Office, Code 201
NAVY PERSONNEL R&D CENTER
SAN DIEGO, CA 92152

Navy	Navy
1 Library, Code P201L Navy Personnel R&D Center San Diego, CA 92152	1 Roger W. Remington, Ph.D Code L52 NAMRL Pensacola, FL 32508
6 Commanding Officer Naval Research Laboratory Code 2627 Washington, DC 20390	1 Dr. Bernard Rinland (03B) Navy Personnel R&D Center San Diego, CA 92152
1 Psychologist ONR Branch Office Bldg 114, Section D 666 Summer Street Boston, MA 02210	1 Mr. Arnold Rubenstein Naval Personnel Support Technology Naval Material Command (08T244) Room 1044, Crystal Plaza #5 2221 Jefferson Davis Highway Arlington, VA 20360
1 Psychologist ONR Branch Office 536 S. Clark Street Chicago, IL 60605	1 Dr. Worth Scanland Chief of Naval Education and Training Code N-5 NAS, Pensacola, FL 32508
1 Office of Naval Research Code 437 900 N. Quincy SStreet Arlington, VA 22217	1 Dr. Robert G. Smith Office of Chief of Naval Operations OP-987H Washington, DC 20350
5 Personnel & Training Research Programs (Code 453) Office of Naval Research Arlington, VA 22217	1 Dr. Alfred F. Smode Training Analysis & Evaluation Group (TAEG) Dept. of the Navy Orlando, FL 32813
1 Psychologist ONR Branch Office 1030 East Green Street Pasadena, CA 91101	1 Dr. Richard Sorensen Navy Personnel R&D Center San Diego, CA 92152
1 Office of the Chief of Naval Operations Research Development & Studies Branch (OP-115) Washington, DC 20350	1 W. Gary Thomson Naval Ocean Systems Center Code 7132 San Diego, CA 92152
1 LT Frank C. Petho, MSC, USN (Ph.D) Code L51 Naval Aerospace Medical Research Laborat Pensacola, FL 32508	1 Dr. Robert Wisher Code 309 Navy Personnel R&D Center San Diego, CA 92152
1 DR. RICHARD A. POLLAK ACADEMIC COMPUTING CENTER U.S. NAVAL ACADEMY ANNAPOLIS, MD 21402	

Army

- 1 Technical Director
U. S. Army Research Institute for the
Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333
- 1 HQ USAREUE & 7th Army
ODCSOPS
USAAREUE Director of GED
APO New York 09403
- 1 DR. RALPH DUSEK
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333
- 1 DR. FRANK J. HARRIS
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333
- 1 Col Frank Hart
Army Research Institute for the
Behavioral & Social Sciences
5001 Eisenhower Blvd.
Alexandria, VA 22333
- 1 Dr. Michael Kaplan
U.S. ARMY RESEARCH INSTITUTE
5001 EISENHOWER AVENUE
ALEXANDRIA, VA 22333
- 1 Dr. Milton S. Katz
Training Technical Area
U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333
- 1 Dr. Harold F. O'Neil, Jr.
Attn: PERI-OK
Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333
- 1 Dr. Robert Sasnor
U. S. Army Research Institute for the
Behavioral and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333

Army

- 1 Commandant
US Army Institute of Administration
Attn: Dr. Sherrill
FT Benjamin Harrison, IN 46256
- 1 Dr. Frederick Steinheiser
U. S. Army Reserch Institute
5001 Eisenhower Avenue
Alexandria, VA 22333
- 1 Dr. Joseph Ward
U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

Air Force

- 1 Dr. Earl A. Alluisi
HQ, AFHRL (AFSC)
Brooks AFB, TX 78235
- 1 Dr. Genevieve Haddad
Program Manager
Life Sciences Directorate
AFOSR
Rolling AFB, DC 20332
- 1 Dr. Ross L. Morgan (AFHRL/LR)
Wright -Patterson AFB
Ohio 45433
- 1 Research and Measurement Division
Research Branch, AFMPC/MPCYPR
Randolph AFB, TX 78148
- 1 Dr. Marty Rockway (AFHRL/TT)
Lowry AFB
Colorado 80230
- 1 Jack A. Thorpe, Maj., USAF
Naval War College
Providence, RI 02846

Marines

- 1 H. William Greenup
Education Advisor (E031)
Education Center, MCDEC
Quantico, VA 22134
- 1 Director, Office of Manpower Utilization
HQ, Marine Corps (MPU)
ECB, Bldg. 2009
Quantico, VA 22134
- 1 DR. A.L. SLAFKOSKY
SCIENTIFIC ADVISOR (CODE RD-1)
HQ, U.S. MARINE CORPS
WASHINGTON, DC 20380

Other DoD

- 12 Defense Technical Information Center
Cameron Station, Bldg 5
Alexandria, VA 22314
Attn: TC
- 1 Dr. Craig I. Fields
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22209
- 1 Dr. Dexter Fletcher
ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BLVD.
ARLINGTON, VA 22209
- 1 Military Assistant for Training and
Personnel Technology
Office of the Under Secretary of Defense
for Research & Engineering
Room 3D129, The Pentagon
Washington, DC 20301

Civil Govt

- 1 Dr. Susan Chipman
Learning and Development
National Institute of Education
1200 19th Street NW
Washington, DC 20208
- 1 Dr. Joseph I. Lipson
SEDR W-638
National Science Foundation
Washington, DC 20550
- 1 Dr. John Mays
National Institute of Education
1200 19th Street NW
Washington, DC 20208
- 1 William J. McLaurin
Rm. 301, Internal Revenue Service
2221 Jefferson Davis Highway
Arlington, VA 22202
- 1 Dr. Arthur Melmed
National Institute of Education
1200 19th Street NW
Washington, DC 20208
- 1 Dr. Andrew R. Molnar
Science Education Dev.
and Research
National Science Foundation
Washington, DC 20550
- 1 Dr. H. Wallace Sinaiko
Program Director
Manpower Research and Advisory Services
Smithsonian Institution
801 North Pitt Street
Alexandria, VA 22314
- 1 Dr. Joseph L. Young, Director
Memory & Cognitive Processes
National Science Foundation
Washington, DC 20550

Non Govt

- 1 Dr. John R. Anderson
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213
- 1 DR. MICHAEL ATWOOD
SCIENCE APPLICATIONS INSTITUTE
40 DENVER TECH. CENTER WEST
7935 E. PRENTICE AVENUE
ENGLEWOOD, CO 80110
- 1 1 psychological research unit
Dept. of Defense (Army Office)
Campbell Park Offices
Canberra ACT 2600, Australia
- 1 Dr. Alan Baddeley
Medical Research Council
Applied Psychology Unit
15 Chaucer Road
Cambridge CB2 2EF
ENGLAND
- 1 Dr. Patricia Baggett
Department of Psychology
University of Denver
University Park
Denver, CO 80202
- 1 Mr Avron Barr
Department of Computer Science
Stanford University
Stanford, CA 94305
- 1 Dr. Nicholas A. Bond
Dept. of Psychology
Sacramento State College
600 Jay Street
Sacramento, CA 95819
- 1 Dr. Lyle Bourne
Department of Psychology
University of Colorado
Boulder, CO 80309
- 1 Dr. John S. Brown
XEROX Palo Alto Research Center
3337 Coyote Road
Palo Alto, CA 94304

Non Govt

- 1 Dr. Bruce Buchanan
Department of Computer Science
Stanford University
Stanford, CA 94305
- 1 Dr. Pat Carpenter
Department of Psychology
Carnegie-Mellon University
Pittsburgh, PA 15213
- 1 Dr. John B. Carroll
Psychometric Lab
Univ. of No. Carolina
Davie Hall 013A
Chapel Hill, NC 27514
- 1 Charles Myers Library
Livingstone House
Livingstone Road
Stratford
London E15 2LJ
ENGLAND
- 1 Dr. William Chase
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213
- 1 Dr. Micheline Chi
Learning R & D Center
University of Pittsburgh
3939 O'Hara Street
Pittsburgh, PA 15213
- 1 Dr. William Clancey
Department of Computer Science
Stanford University
Stanford, CA 94305
- 1 Dr. Allan M. Collins
Bolt Beranek & Newman, Inc.
50 Moulton Street
Cambridge, Ma 02138
- 1 Dr. Lynn A. Cooper
Department of psychology
Uris Hall
Cornell University
Ithaca, NY 14850

Non Govt

- 1 Dr. Meredith P. Crawford
American Psychological Association
1200 17th Street, N.W.
Washington, DC 20036
- 1 Dr. Hubert Dreyfus
Department of Philosophy
University of California
Berkeley, CA 94720
- 1 LCOL J. C. Eggenberger
DIRECTORATE OF PERSONNEL APPLIED RESEARCH
NATIONAL DEFENCE HQ
101 COLONEL BY DRIVE
OTTAWA, CANADA K1A 0K2
- 1 Dr. Ed Feigenbaum
Department of Computer Science
Stanford University
Stanford, CA 94305
- 1 Mr. Wallace Feurzeig
Bolt Beranek & Newman, Inc.
50 Moulton St.
Cambridge, MA 02138
- 1 Dr. Victor Fields
Dept. of Psychology
Montgomery College
Rockville, MD 20850
- 1 Dr. John R. Frederiksen
Bolt Beranek & Newman
50 Moulton Street
Cambridge, MA 02138
- 1 Dr. Alinda Friedman
Department of Psychology
University of Alberta
Edmonton, Alberta
CANADA T6G 2E9
- 1 DR. ROBERT GLASER
LRDC
UNIVERSITY OF PITTSBURGH
3939 O'HARA STREET
PITTSBURGH, PA 15213

Non Govt

- 1 Dr. Marvin D. Glock
217 Stone Hall
Cornell University
Ithaca, NY 14853
- 1 DR. JAMES G. GREENO
LRDC
UNIVERSITY OF PITTSBURGH
3939 O'HARA STREET
PITTSBURGH, PA 15213
- 1 Dr. Harold Hawkins
Department of Psychology
University of Oregon
Eugene OR 97403
- 1 Dr. Barbara Hayes-Roth
The Rand Corporation
1700 Main Street
Santa Monica, CA 90406
- 1 Dr. Frederick Hayes-Roth
The Rand Corporation
1700 Main Street
Santa Monica, CA 90406
- 1 Mr. Richards J. Heuer, Jr.
27585 Via Sereno
Carmel, CA 92923
- 1 Dr. James R. Hoffman
Department of Psychology
University of Delaware
Newark, DE 19711
- 1 Library
HumRRO/Western Division
27857 Berwick Drive
Carmel, CA 93921
- 1 Dr. Earl Hunt
Dept. of Psychology
University of Washington
Seattle, WA 98105

Non Govt

- 1 DR. LAWRENCE B. JOHNSON
LAWRENCE JOHNSON & ASSOC., INC.
Suite 103
4545 42nd Street, N.W.
Washington, DC 20016
- 1 Dr. Steven W. Keele
Dept. of Psychology
University of Oregon
Eugene, OR 97403
- 1 Dr. Walter Kintsch
Department of Psychology
University of Colorado
Boulder, CO 80302
- 1 Dr. Stephen Kosslyn
Harvard University
Department of Psychology
38 Kirkland Street
Cambridge, MA 02138
- 1 Mr. Marlin Kroger
1117 Via Goleta
Palos Verdes Estates, CA 90274
- 1 Dr. Jill Larkin
Department of Psychology
Carnegie Mellon University
Pittsburgh, PA 15213
- 1 Dr. Alan Lessgold
Learning R&D Center
University of Pittsburgh
Pittsburgh, PA 15260
- 1 Dr. Michael Levine
Department of Educational Psychology
210 Education Bldg.
University of Illinois
Champaign, IL 61801
- 1 Dr. Robert A. Levit
Director, Behavioral Sciences
The IDI Corporation
7315 Jones Branch Drive
McLean, VA 22101

Non Govt

- 1 Dr. Robert Linn
College of Education
University of Illinois
Urbana, IL 61801
- 1 Dr. Mark Miller
Computer Science Laboratory
Texas Instruments, Inc.
Mail Station 371, P.O. Box 225936
Dallas, TX 75265
- 1 Dr. Allen Munro
Behavioral Technology Laboratories
1845 Elena Ave., Fourth Floor
Redondo Beach, CA 90277
- 1 Dr. Donald A Norman
Dept. of Psychology C-009
Univ. of California, San Diego
La Jolla, CA 92093
- 1 Dr. Jesse Orlansky
Institute for Defense Analyses
400 Army Navy Drive
Arlington, VA 22202
- 1 MR. LUIGI PETRULLO
2431 N. EDGEWOOD STREET
ARLINGTON, VA 22207
- 1 Dr. Martha Polson
Department of Psychology
University of Colorado
Boulder, CO 80302
- 1 DR. PETER POLSON
DEPT. OF PSYCHOLOGY
UNIVERSITY OF COLORADO
BOULDER, CO 80309
- 1 DR. DIANE M. RAMSEY-KLEE
R-K RESEARCH & SYSTEM DESIGN
3947 RIDGEMONT DRIVE
MALIBU, CA 90265

Non Govt

- 1 Dr. Fred Reif
SESAME
c/o Physics Department
University of California
Berkeley, CA 94720
- 1 Dr. Andrew M. Rose
American Institutes for Research
1055 Thomas Jefferson St. NW
Washington, DC 20007
- 1 Dr. Ernst Z. Rothkopf
Bell Laboratories
600 Mountain Avenue
Murray Hill, NJ 07974
- 1 Dr. David Rumelhart
Center for Human Information Processing
Univ. of California, San Diego
La Jolla, CA 92093
- 1 PROF. FUMIKO SAMEJIMA
DEPT. OF PSYCHOLOGY
UNIVERSITY OF TENNESSEE
KNOXVILLE, TN 37916
- 1 DR. WALTER SCHNEIDER
DEPT. OF PSYCHOLOGY
UNIVERSITY OF ILLINOIS
CHAMPAIGN, IL 61820
- 1 Dr. Alan Schoenfeld
Department of Mathematics
Hamilton College
Clinton, NY 13323
- 1 DR. ROBERT J. SEIDEL
INSTRUCTIONAL TECHNOLOGY GROUP
NUMBER
800 N. WASHINGTON ST.
ALEXANDRIA, VA 22314
- 1 Committee on Cognitive Research
Dr. Lonnie R. Sherrod
Social Science Research Council
605 Third Avenue
New York, NY 10016

Non Govt

- 1 Dr. Robert Smith
Department of Computer Science
Rutgers University
New Brunswick, NJ 08903
- 1 Dr. Richard Snow
School of Education
Stanford University
Stanford, CA 94305
- 1 Dr. Robert Sternberg
Dept. of Psychology
Yale University
Box 11A, Yale Station
New Haven, CT 06520
- 1 DR. ALBERT STEVENS
BOLT BERANEK & NEWMAN, INC.
50 MOULTON STREET
CAMBRIDGE, MA 02138
- 1 Dr. David Stone
ED 236
SUNY, Albany
Albany, NY 12222
- 1 DR. PATRICK SUPPES
INSTITUTE FOR MATHEMATICAL STUDIES IN
THE SOCIAL SCIENCES
STANFORD UNIVERSITY
STANFORD, CA 94305
- 1 Dr. Brad Simpson
Psychometric Research Group
Educational Testing Service
Princeton, NJ 08541
- 1 Dr. Kikumi Tatsuoka
Computer Based Education Research
Laboratory
252 Engineering Research Laboratory
University of Illinois
Urbana, IL 61801
- 1 Dr. John Thomas
IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598

Non Govt

- 1 DR. PERRY THORNDYKE
THE RAND CORPORATION
1700 MAIN STREET
SANTA MONICA, CA 90406
- 1 Dr. Douglas Towne
Univ. of So. California
Behavioral Technology Labs
1845 S. Elena Ave.
Redondo Beach, CA 90277
- 1 Dr. J. Uhlauer
Perceptronics, Inc.
6271 Variel Avenue
Woodland Hills, CA 91364
- 1 Dr. Benton J. Underwood
Dept. of Psychology
Northwestern University
Evanston, IL 60201
- 1 Dr. Phyllis Weaver
Graduate School of Education
Harvard University
200 Larsen Hall, Appian Way
Cambridge, MA 02138
- 1 Dr. David J. Weiss
H660 Elliott Hall
University of Minnesota
75 E. River Road
Minneapolis, MN 55455
- 1 Dr. Keith T. Wescourt
Information Sciences Dept.
The Rand Corporation
1700 Main St.
Santa Monica, CA 90406
- 1 DR. SUSAN F. WHITELY
PSYCHOLOGY DEPARTMENT
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS 66044
- 1 Dr. J. Arthur Woodward
Department of Psychology
University of California

DATE
FILMED
— 8